

Biomass Research and Development Technical Advisory Committee

2014 Recommendations

Contents

INTRODUCTION.....	1
COMMITTEE RECOMMENDATIONS	1
Biomass Research and Development Initiative (BRDI).....	1
Conversion Recommendations.....	3
Products, Markets, and Systems Recommendations	5
Feedstocks and Logistics Recommendations	6
APPENDIX A	8

INTRODUCTION

The Technical Advisory Committee (the Committee) for the Biomass Research and Development Initiative (BRDI) was authorized through section 9008(d) of the Food, Conservation, and Energy Act of 2008 (FCEA) and re-authorized in the Agricultural Act of 2014. The Committee is obligated to report to the Biomass Research and Development Board (the Board) on the following.

In §(d)(3)(B), evaluate and make recommendations in writing to the Board regarding whether:

- ❖ Funds authorized for the Initiative are distributed and used in a manner that is consistent with the objectives, purposes, and considerations of the Biomass Research and Development Initiative [§(e)(2)]
- ❖ Solicitations are open and competitive with awards made annually
- ❖ Objectives and evaluation criteria of the solicitations are clearly stated and minimally prescriptive with no areas of special interest
- ❖ The points of contact [§(c)(2)(A)] are funding proposals under this title that are selected on the basis of merit, as determined by an independent panel of scientific and technical peers predominantly from outside the Departments of Agriculture and Energy
- ❖ Activities under this title are carried out in accordance with the title.

Annual reporting obligations for the Committee are stated in §(g). Additionally, the Committee charter supports the formation of subcommittees that can address particular matters for the Committee as a whole. The Committee currently operates with three subcommittees:

1. Conversion
2. Products, Markets, and Systems
3. Feedstocks and Logistics.

COMMITTEE RECOMMENDATIONS

Biomass Research and Development Initiative (BRDI)

The Committee's 2014-specific reporting obligations and recommendations for BRDI are as follows:

- ❖ Funds authorized are distributed and used in a manner that is consistent with the objectives, purposes, and considerations of the Biomass Research and Development Initiative.

BRDI is unique among federally funded programs that advance biomass-based renewable energy technologies. With a focus on research and development (R&D), BRDI has a critical role in the science value chain. Several agencies support fundamental biomass-related scientific research. There are also several applied research grant and loan guarantee programs that support and de-risk the commercialization of advanced technologies. BRDI serves as an important translational link for accelerating potential early-stage technologies toward application and commercialization.

If the nation places a high priority on accelerating the development of a secure biobased economy, BRDI will require appropriations that are similar to what was provided prior to the funding cuts implemented in December 2012. With only \$3 million provided annually, this important translational portion of the value chain will limit the progression of basic research toward strategic applications.

1. **Problem Statement:** Budget cuts and focused federal R&D solicitations have hindered the progression and actualization of potential benefits from BRDI.

Recommendations:

- BRDI should explore collaboration opportunities with other federal agencies (beyond DOE and USDA), foundations, corporations, and other funding sources to better leverage its resources.
- BRDI should solicit proposals for work and increase public outreach efforts to demonstrate the current and potential societal benefits of the bioeconomy (e.g., job creation, reduced oil imports, greenhouse gas reductions, and positive regional impacts).
- BRDI should ensure that research funding opportunities and results are shared broadly with underrepresented and disadvantaged communities.
- BRDI should develop and track additional performance metrics that provide insights on outcomes and accomplishments, such as return on investment, job creation, and commercial activity.

❖ **Solicitations are open and competitive with awards made annually.**

Funds appropriated through BRDI were not distributed in calendar year 2014. Consequently, the Committee could not evaluate how the program was conducted during the past year. Nevertheless, the U.S. Department of Agriculture's (USDA's) National Institute of Food and Agriculture (NIFA), and the U.S. Department of Energy's (DOE's) Bioenergy Technologies Office (BETO) presented briefings to the Committee during 2014 and requested input for a pending solicitation (see Appendix A). The release of a BRDI solicitation is anticipated for December 2014. The Committee commends the two lead agencies in their preparatory work for the next solicitation, as well as for leveraging additional funds.

At the time of this report, USDA, in conjunction with DOE's Office of Energy Efficiency and Renewable Energy (EERE), issued a notice of intent for a request for applications (RFA), entitled "Fiscal Year (FY) 2015 Biomass Research and Development Initiative."

❖ **Objectives and evaluation criteria of the solicitations are clearly stated and minimally prescriptive, with no areas of special interest.**

For FY 2015, BRDI will require that funded projects address only one of the following three legislatively mandated technical areas: (1) Feedstocks development, (2) Biofuels and Biobased Products Development, or (3) Biofuels Development Analysis.

2. **Problem Statement:** The Committee does not have a complete picture of the types of proposals submitted in the pre-application and final submission stages.

Recommendation: Develop a checklist for proposal developers to complete that will provide data that can be tracked. The Committee recommends that BRDI implements a tracking process similar to the one used by the National Science Foundation.

❖ **The points of contact [§(c)(2)(A)] are funding proposals under this title that are selected on the basis of merit, as determined by an independent panel of scientific and technical peers predominantly from outside the Departments of Agriculture and Energy.**

USDA and DOE officials that are responsible for the implementation of BRDI have provided excellent leadership. They have sought guidance from a wide variety of stakeholders and developed a useful and informative set of performance metrics.

❖ **Activities under this title are carried out in accordance with the title.**

The Committee has the following recommendations for improving BRDI further:

3. **Problem Statement:** The Committee wishes to better understand the scope of biomass-related projects funded by other federal research programs—particularly in agencies that are represented on the multi-agency BRDI Board [§(c)].

Recommendation: Obtain focus areas and program summaries for significant federal biomass-to-energy programs and present them in a manner similar to the BRDI program update that was provided by USDA-NIFA.

4. **Problem Statement:** Dialogue between the Board and Committee in response to the Committee’s annual report is slow and unsatisfactory. Committee members understand that reviewing recommendations and approving the annual report takes time; however, the lack of timely feedback and turnover in Committee members each year prevents the Committee from receiving formal responses on annual recommendations. The amount of feedback the Committee receives could be enhanced through greater interaction between the Committee and the BRDI Operations Committee.

Recommendation: Members of the BRDI Operations Committee should be encouraged to attend Committee meetings to become more aware of Committee concerns on an ongoing basis.

Conversion Recommendations

The Committee’s 2015 Conversion recommendations are as follows:

5. **Problem Statement:** Biomass conversion plants require substantially higher capital expenditure per gallon capacity than starch/sugar ethanol plants or biodiesel plants (first-generation). This is due to the complexity of biomass processing, which entails a higher number of unit operations than conventional biofuel facilities. The common solution for high capital expenditure is to increase scale by building larger facilities. In the case of biomass processing plants and biorefineries, the costs of transporting biomass greater distances rises rapidly and can offset any savings from reduced per gallon capital expenditures. Further, higher capital costs increase perceived project risk, as well as reduce the likelihood of obtaining investment funding.

R&D Recommendations:

- Emphasize the development of technologies that have viable economics for early stage plants that attract capital investment for the subsequent expansion of similarly designed facilities. This targeted government investment in R&D and process optimization (in addition to stable and supportive policy) will enable the new industry to grow and prosper. Priority should go to disruptive technology investments that can significantly reduce the capital and operating costs of advanced biofuels and biochemicals. This should include funding additional basic research, targeted research on specific elements of processes, and programs that address operational issues of current pilot and/or commercial demonstration facilities. Research investments should support technologies that can displace fossil fuels on a cost-competitive basis, including a reasonable return on capital. Research in the following areas within the conversion sector will help to address the following barriers.

Densification, Storage, and Transport

In order to maintain quality feedstock supply and support low-cost operations, more work is needed to study the stability and preprocessing of feedstocks. Systems that are applied today have not been specifically designed for biomass processes.

Pretreatment

Pretreatment technologies need improvement to provide efficient conversion of feedstocks into higher-concentration sugar solutions derived from processes with relatively low capital costs, as well as processes that minimize sugar degradation and inhibitory byproducts. To help with breakthroughs, the government must perform R&D to new technologies, such as cavitation, ultra-sonic, novel chemistries, new enzymes, and reactor technologies. For thermochemical (and biochemical) pathways, more research is needed to support particle size/physical handling of solid materials.

Fermentation

Capital costs for industrial fermentation of structural carbohydrates are excessive (relative to capital costs for first-generation ethanol). Fermentation needs to be viable in low-cost simple tanks with minimal aeration, instead of highly specialized fermentation vessels. Novel vessel design and processing strategies that specifically improve productivity should also be considered.

Organisms need further improvement to handle a wider variety of sugar types (e.g., glucose, sucrose, xylose, arabinose) and to be more robust to impurities in the hydrolysate.

Thermochemical Conversion and Catalysis

Compared to existing knowledge about converting petrochemical feedstocks, there is not a solid understanding of catalytic conversion of biomass feedstocks to biofuels and biochemicals. There is a lack of knowledge about how reactions occur on the surface of catalysts and how to limit the fouling and deactivation caused by impurities in the biomass feedstock. Novel catalysts, catalyst supports, and reactor designs should be explored. Additionally, some basic R&D activities should be supported in order to gain a better understanding of molecule and surface interactions. Biomass conversion systems are also more complex because of the predominance of water and other oxygenates in the process systems.

Separations

Separation processes are particularly difficult and costly because of the large amounts of water involved in biomass systems. Product concentrations in the hydrolysate are often lower than in petroleum systems. There is a need to develop new membrane and absorption/adsorption technologies, novel molecular recognition systems, nanotechnology, or other recovery strategies to significantly reduce capital and operating costs.

Modeling and Simulation

Enable advanced simulation techniques to be applied to biomass processing. Examples would include three-phase trickle bed reactors, chromatography, etc.

- Nth plant economics are not realistic for driving early investment. Early pioneer plants are typically more expensive for a given plant size and require a higher rate of return because of the higher risk associated with new technology. They should expect a more realistic rate of commercial progress in order to have a better picture of rate of return and make design cases relevant to the commercial scene. There is a need for a dynamic model to reflect risks and return on investment/hurdle rate adjustment over time.
- Expanded research is needed to better integrate biomass processing with the petroleum industry.
- Develop new technologies that focus on alignment with existing infrastructure, such as biobased diesel and jet fuels.
- Develop fuels that are compatible with the existing delivery infrastructure.
- DOE and USDA should do a periodic review of technologies to ensure best processes are in place. This should consider work in aromatics from lignin as potential opportunities.
- Develop an integrated multi-year ‘program’ plan among related federal agencies for building the bioeconomy. Agencies should coordinate to develop a high-level, overarching plan that reflects each department/agencies efforts/resources, as well as activities to be leveraged.
- Optimize the loan guarantee processes to realistically recognize the risk of new biofuels/bioproducts plants, and better coordinate USDA/DOE efforts.
- In order to establish a successful biofuels industry, there needs to be major policies to drive it forward (i.e., maintaining cellulosic Renewable Fuel Standard 2 (RFS2) as originally enacted and others) and a major increase in R&D funding dedicated to crossing major technical barriers.

Products, Markets, and Systems Recommendations

The Committee’s 2015 Products, Markets, and Systems recommendations are as follows:

6. **Problem Statement:** The creation of fuels that are not true drop-in biofuels can drive significant distribution, retail, and end-user infrastructure costs. The use of true drop-in biofuels minimizes issues with products, markets, and systems as is the case with the development of aviation turbine fuels.

Recommendation: Research is needed in achieving true low-cost drop-in biofuels.

7. **Problem Statement:** Government and industry have made substantial investments in ethanol research and production capacity, with several recently opened, new technology, cellulosic ethanol production facilities pointing to future expansion. Nonetheless, higher ethanol blends are not used in proportion to the size of the capable fleet and the amount of fuel that could be produced. Research is needed to examine how higher ethanol blends could be adopted more quickly in retail markets where they are allowed and there is a large compatible fleet. [*The U.S. fleet has approximately 7% of its vehicles warranted for ethanol flex-fuel up to E85 and 10% warranted for E15 (with two-thirds or three-quarters covered under the Environmental Protection Agency (EPA) partial waivers under the Clean Air Act). These percentages are higher in states with more domestic vehicles and newer vehicles, such as Michigan. Yet, according to DOE, less than 3,000 stations offer E85, and according to “Choose Ethanol,” only 78 stations*

offer E15. If the percentage of higher blend capable stations matched the percentage of higher blend capable vehicles, there would be far more stations offering higher ethanol blends to the public.]

Analysis Recommendation:

- Analysis is needed to address how to accelerate the installation of higher blend dispensers. What factors facilitated adoption in successful markets such as Brazil, Sweden, and Thailand? What factors facilitated the adoption of E10 in Canada and the United States? The research must identify policy differences and allocate success factors. What are the effects of potential policies on increasing the adoption/penetration of alternative fuel use and infrastructure?
8. **Problem Statement:** Bioproducts are underexploited, and they could enhance overall biofuel production if they were further developed and marketed.

Planning Recommendations:

- Support research on specialty and high-value products derived from biomass to build a technology platform that will facilitate the low-cost production of fuels. Increase emphasis on developing valuable co-products that complement biofuel-making processes.
- Support programs that develop bio-derived products that can survive and thrive on their own without subsidy or preference. Develop a pathway to integrate biofuels/chemicals into the petroleum economy. This should include working with current petroleum producers and refiners to consider the impact of increasing the bioeconomy on the traditional fossil-related industry.
- Examine how to recalculate the total carbon impact of products for the purposes of federal procurement and consumer outreach.
- Create, maintain, and share widely a database of federally and privately developed bioproducts to inform federal and private initiatives. Non-federal examples include activities with national crop boards, such as the Soybean Board and Corn Growers Association.
- Encourage more educational outreach on bioproducts with “show and tell” events in Washington, D.C., and elsewhere. This outreach would not be limited to the public sector; it would also include technology transfer showcases.

Feedstocks and Logistics Recommendations

The Committee’s 2015 Feedstocks and Logistics recommendations are as follows:

9. **Problem Statement:** Sufficient volumes of advanced biomass feedstocks are not delivered continuously to the processor at low enough unit costs. Land owners/operators must achieve sufficient economic return to adopt bioenergy feedstocks and new production systems. Regional differences require unique approaches to addressing the general logistic issues (e.g., harvest, transportation, storage).

R&D Recommendations:

- Increase yield and decrease the unit cost of feedstocks per acre.
 - Better utilize and maximize the use of existing feedstock resources (waste streams/agricultural residuals).

- Prioritize feedstocks that require minimal inputs of water, nutrients, and energy to achieve socially, economically, and environmentally sustainable yields.
- Encourage farming systems that maximize productivity throughout the year (e.g., intensify the use of existing land, thereby creating “virtual acres”). No feedstock should be excluded as long as it can show it meets volumetric needs and economic viability.
- Ensure that feedstocks are continuously available to processors.
 - Develop and demonstrate improved logistics for feedstock procurement and distribution by aggregating, processing, blending, and storing feedstocks.
 - Establish processes to efficiently deconstruct, increase energy density, remove oxygen, improve handling, and stabilize during storage.
- Explore ways to expand the land base for producing biomass to include tribal, federal, and public lands, as well as lands in need of reclamation and environmental mitigation (EPA Repowering America, DOE Office of Science).
- Demonstrate operating feedstock supply chains (at scale) by region to model and to increase sustainability:
 - Represent multiple examples of functioning supply chains that entail collecting, preprocessing, and shipping biomass to the various end users. Such work must support long-term (at least five harvest cycles) field trials at scale for key biomass feedstock data.
 - Implement coordinated R&D in these supply chains that includes assessments of land use, greenhouse gas emissions, rural economic development, market development, and continuously improved yields.
- Require all federally funded R&D projects focused on feedstock production to submit resulting data to public databases, such as BETO’s Knowledge Discovery Framework and USDA databases. Submitted data must include standardized metadata. Appropriate considerations should be provided for publication and protection of intellectual property.

Analysis Recommendation:

- Conduct research that results in a better understanding of socioeconomic drivers that influence land owner behavior. This will identify factors that will cause land owners to participate or not participate in producing energy crops.

10. Problem Statement: A diversity of feedstocks gives rise to different bioproduct yields and compositions.

R&D Recommendation:

- Better characterize and standardize analysis of the chemical and physical properties of feedstocks. Conduct coordinated R&D to understand how variations in plant nutrition, climate, soils, and stress affect chemical composition, and how impacts of variation might be minimized. Analyze the stability and composition of different feedstocks in different environments and define how losses can be mitigated and recovery of desired products maximized.

Analysis Recommendation:

- Implement R&D programs to optimize the mass and energy balances of the complete supply chain while capturing maximum efficiencies throughout. Establish industry standards for feedstock characterization. Review existing relevant research and specification limits of existing supply chains. Conduct feasibility analyses between large centralized biorefineries and distributed pretreatment facilities.

APPENDIX A

Dr. Daniel Cassidy of NIFA requested input from the Committee during the 2014 Q1 meeting in order to guide planning for a pending solicitation. A summary of the Committee's guidance is as follows:

- ❖ Guidance from the Committee on suggestions to best implement BRDI with the current funding approved in the 2014 Farm Bill. This funding allocates \$3 million annually for five years. In response to Dr. Cassidy's request for suggestions, the Committee—during its 2014 Q1 meeting—formulated, discussed, and voted on the best ideas to assist him in planning for a 2014 BRDI solicitation. The Committee voted on and approved the following recommendations in no particular order of priority:
 - That BRDI funds are released annually and not deferred in order to roll funds together.
 - That BRDI funds several early-stage, innovative, high-reward “proof of concept” projects for biofuels and/or bioproducts.
 - Prioritization should be given for supporting small, both novel and compelling, proposals in “sustainable feedstock, production, and logistics;” “biomass conversion;” or “products, markets, and systems.”
 - Suggest award amounts ranging from \$100,000–\$500,000 based on the annual \$3 million allocation.
 - Encourage, where possible, a match in cost share for BRDI funds.
 - Challenges and gaps identified in the 2013 Committee Grand Challenge Recommendations could be used as specific areas for consideration.
 - That the BRDI funding opportunity announcement should support either systems-level or sub-system integration analyses.
 - Prioritize analytical work supportive of advancing the development of sustainable and economically competitive biofuels and bioproducts.
 - Identify economically and environmentally relevant R&D issues and focus R&D on the lack of knowledge in such systems.
 - Specific areas for consideration can be found in 2013 Committee Grand Challenge Recommendations.